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DRONES IN CONSTRUCTION – 2015 SURVEY REPORT

INTRODUCTION

ConstructionPro Network's first *Drones in Construction* survey, conducted in the summer of 2014, was a short four-part questionnaire to obtain the industry's pulse as drones were just beginning to be used on construction sites. Surprisingly, 73% of respondents said they were aware of drone use on construction sites, while 29% reported having hands-on experience. The leading uses reported were aerial photography, inspection, safety monitoring and surveying. The number of respondents aware of drones in the 2015 survey jumped to 88%. Leading use cases were similar, but the 2015 survey was expanded to 10 questions to gather more detail on how they were used, what drones were flown, what cameras were used and to learn best practices based on user experiences.

EXECUTIVE SUMMARY

Drones have proven themselves to be a useful tool on construction sites. 100% of those surveyed that have actually used a drone on a project reported it to be a success and are very satisfied with both the experience of using a drone and the quality of the results obtained. The primary cause precluding more widespread use is the Federal Aviation Administration's (FAA) regulations on drones in the national airspace. Current FAA regulations allow operation only after receiving a written exemption that meet certain safety and operational requirements, such as having an active pilot's license. Regardless, benefits abound and many users are deploying drones despite the risks.

The low hanging fruit is for those who previously hired a helicopter to take aerial photos; these users are finding photos from drones are much less costly, safer to obtain and are of higher quality. The rest of the industry is finding a multitude of benefits from aerial photography and the collection of data with laser, infrared and other sensors that can be used to produce 3D maps for earthwork calculations, thermal imaging for inspection, and point clouds for BIM models, for example. Survey respondents reported a number of unexpected side benefits, such as improved communication with other team members, a boost to morale and just plain fun. This report presents many of the comments received, organized by benefits and outcomes. Survey respondents generously provided best practices in the preparation and operation of drones on a construction site.

The use of drones on construction sites is clearly compelling and likely to be the wave of the future. With the expectation of FAA proposed rules to be issued in 2016 making drone use more practical, construction professionals may want to start preparations now and build on the experiences of our survey respondents.

BACKGROUND

At the time of the survey, the FAA had not yet issued its proposed new rules for commercial use of drones. What has changed, however, was the issuance of the exemptions for commercial use under the FAA's "333" program. This program allows the use of a drone for a commercial purpose provided certain requirements are met, primarily that a licensed pilot operates the drone. Since the first exemption was issued in September 2014, more than 3,155 exemptions have been issued. *ConstructionPro Network's* analysis of the exemptions has determined that approximately 18% are requests by construction or engineering companies, or by third parties that specifically mentioned providing services to the A/E/C, utility and transportation industries. With that in mind, the survey was designed to poll the industry on potential usage in anticipation of new FAA rules or actual usage without FAA approval.

In addition to applications anticipated to be used if the FAA loosens the requirements, we sought answers to the following:

- Will drones be purchased and flown by in-house staff, or outsourced to a service?
- What are current reasons for not using a drone to date?
- If already flying one's own drone, what make/model and what camera or sensors are used?
- Describe in detail what applications the drone has been used for.
- Provide detail of the benefits obtained with drone use, including unexpected outcomes.
- What best practices have evolved in flying a drone or hiring a service?

As seen below, there is clearly a keen sense of interest in the use of drones in the construction industry. A large segment of potential users are sitting on the fence waiting to see how the new FAA regulations shape up, while concurrently researching drone technology, insurance issues and safety practices.

SURVEY RESULTS

Participant Demographics

Contractors, construction managers and design builders comprised 50% of the respondents. The rest of the respondents represent a broad spectrum of the industry, led by architects/engineers at 14%. See figure 1.

Figure 1. Role in construction industry

ROLE	RESPONSES	PERCENT
Contractor	79	38%
Construction Manager/Design-Builder	25	12%
Owner/Owner's Rep	25	12%
Architect/Engineer	28	14%
Manufacturer/Supplier	3	1%
Education (Professor, Student, Researcher)	4	2%
Consultant	3	1%
Surety/Insurance/Safety	3	1%
Other*	9	4%
Not provided	27	13%
	206	

*Includes photographer, facilities manager and other undefined categories

Anticipated usage

With more than 200 respondents, the description of how drones would be used if the FAA approved usage is shown in figure 2 (see page 3). Photography for tracking job progress was the top application at 92% of respondents with marketing second at 74%. In addition to inspection, safety monitoring, surveying and transportation, more than a dozen other uses were suggested, including security monitoring, defense against claims, and our favorite, use in education to observe construction methods via virtual field trips.

Figure 2. Possible use for drone applications - 2015 survey results

WHAT APPLICATIONS WOULD YOU LIKE TO USE A DRONE FOR?	2015
Aerial photography to track job progress	92%
Aerial photography for logistics and production planning	64%
Aerial photography for marketing	74%
Inspection of areas difficult or impossible to access	80%
Safety monitoring and support	57%
Land surveying, thermal imaging, laser scanning or other data collection	52%
Transporting materials	15%
Other	8%

Responses are similar to 2014, with a 32% decrease in the number of people who would use a drone to transport material, and a 21% decrease in those who would use it for land surveying, thermal imaging, laser scanning or other data collection. (See figure 3.) These decreases are probably the result of the industry learning more about capability and practicality of the various applications.

Figure 3. Possible applications for drone usage - 2015 vs. 2014 responses

WHAT APPLICATIONS WOULD YOU LIKE TO USE A DRONE FOR?	2015	2014	CHANGE
Aerial photography to track job progress	92%	93%	-1%
Aerial photography for logistics and production planning	64%	72%	-11%
Aerial photography for marketing	74%	77%	-4%
Inspection of areas difficult or impossible to access	80%	79%	1%
Safety monitoring and support	57%	61%	-7%
Land surveying, thermal imaging, laser scanning or other data collection	52%	66%	-21%
Transporting materials	15%	22%	-32%
Other	8%	7%	14%

In-house or service provider?

69% of respondents stated they would deploy drone usage in-house, leaving 31% preferring to hire a service. Some were on the fence, depending on what the cost would be. Others said they would consider both, depending on the circumstances of the project and the availability of a service provider.

What's holding back drone usage?

Of the canned responses provided, legal status was by far, at 57%, the main reason holding back usage. Safety, cost and insurance issues were secondary reasons holding back usage, in the 30% range each. Unfamiliarity with the technology was mentioned by some, while at least two people expressed concerns with frivolous privacy lawsuits in California. Figure 4 shows the complete breakdown of responses, expressed as "primary concern," "secondary concern" or "not a concern"

Figure 4. Areas of concern currently precluding drone use

AREAS OF CONCERN	PRIMARY CONCERN	SECONDARY CONCERN	NOT A CONCERN
Legal status to operate	56.6%	19.6%	23.8%
Safety of jobsite personnel	28.4%	29.9%	41.8%
Safety of adjacent public	31.9%	31.1%	37.0%
Privacy	20.7%	26.7%	52.6%
Ability to learn how to operate one	16.8%	26.3%	56.9%
Insurance	28.4%	42.6%	29.1%
Cost to buy and operate	31.9%	30.6%	37.5%

Query of actual usage

35% of respondents reported having actually used a drone, with several respondents pointing out they have practiced flying or have used them for personal use in light of the FAA regulations. Figure 5 shows how drones were deployed by those who reported having experience using them. One person used a small tethered motorized dirigible but plans to go to a drone to improve access for design and BIM modeling.

Figure 5. Respondents reports of actual drone usage

WHAT APPLICATIONS WOULD YOU LIKE TO USE A DRONE FOR?	2015 ACTUAL
Aerial photography to track job progress	76%
Aerial photography for logistics and production planning	45%
Aerial photography for marketing	66%
Inspection of areas difficult or impossible to access	59%
Safety monitoring and support	28%
Land surveying, thermal imaging, laser scanning or other data collection	26%
Transporting materials	0%
Other	10%

The actual application percentages are a bit lower than the anticipated usage initially asked of the respondents (see figure 6). The smallest drops were for photography, tracking job progress and inspection, with much larger drops for safety and surveying. No one reported using drones for transporting materials. One person mentioned using the drone for estimating some roof work otherwise not accessible, while another reported using a drone to assist in locating a new structure on a large parcel of land. Building envelope inspection, thermal imaging and site overview on multiple-facility projects was mentioned by one very active user.

Figure 6. Comparison of 2015 actual usage vs. 2015 anticipated usage

COMPARISON OF 2015 ACTUAL VS. 2015 ANTICIPATED	2015 ANTICIPATED	2015 ACTUAL	CHANGE
Aerial photography to track job progress	92%	76%	-21%
Aerial photography for logistics and production planning	64%	45%	-42%
Aerial photography for marketing	74%	66%	-12%
Inspection of areas difficult or impossible to access	80%	59%	-36%
Safety monitoring and support	57%	28%	-104%
Land surveying, thermal imaging, laser scanning or other data collection	52%	26%	-100%
Transporting materials	15%	0%	N/A
Other	8%	7%	-14%

What drones are being used?

2015 saw some initial maturity in the availability and capability of various drone hardware. The most common drone used by contractors has been one of the various Phantom models by DJI industries. Approximately 58% of those deploying a drone used a Phantom 2, 2+ or 3 model, and three people reported using the DJI Inspire. A complete breakdown of the models used is shown in figure 7. Regarding the cameras used, insufficient information was obtained to quantify various types and models, except that 11 people reported using a GoPro Hero 3 or 4; several reported using a “4K” camera and one person reported using a Sony.

Figure 7 - Make and model of drones used by respondents

DRONE MAKE (AND MODEL - WHERE PROVIDED)	NUMBER USED	PERCENT
DJI P1, P2+ or P3	31	58%
DJI Inspire	3	6%
Yuneec Q500	3	6%
SYMA	2	4%
Trimble UX5	1	2%
Airees Blackbird	1	2%
EBEE	1	2%
3D Robotics X8	1	2%
Unknown or not specified, including custom-built, “cheap model (not recommended)”, radio-controlled airplane, used more than one drone, or not willing to disclose	10	19%
	53	

We followed up with several of the respondents about their experiences with the actual drones used. Most users were happy with the equipment. Regarding the DJI Phantom, the drone had good ratings but several people complained about poor customer service, having to resort to online forums and the Internet to provide guidance and solutions. One user of the Yuneec Typhoon was ecstatic with the capability and operation of the drone. He especially liked the near lag-free live feed from the camera on the built-in screen on the radio controller. Several people praised the quality of the GoPro cameras being used.

Benefits and outcomes

100% of the respondents who have used a drone consider its use to be a success. After reading the 30+ comments provided in the survey responses, it's clearly evident that drones are providing a multitude of solid benefits, and a few surprises. For starters, users are impressed with the low cost, quick turnaround and, most of all, the quality of the photos and videos captured.

• *Comments on data, quality and cost*

- "Accurate land surveys"
- "Unique perspective of project, better depth of photos"
- "Better quality photos at a lower price and quicker turnaround"
- "Clients love to see their project from this perspective"
- "Improves relations with the client"
- "Very low cost"
- "Provides a new perspective on real time progress not attainable from the ground or conventional aircraft flyover"
- "The accuracy is very impressive"
- "Cost savings and convenience"
- "Images are fantastic from a marketing point of view"
- "Much quicker than using Total Station"
- "Drone photos can be used to make 3D models"
- "Provides long distance clients with up to date real-time footage of the current status of the work"
- "Ease of operation, cost effective, able to focus on areas of concern"

• *Comments on management aspects*

- "It is beneficial for a full understanding of the project's progress and design issues in hard to see areas. As part of the architectural construction administration process, it helps us, the project Architect, to give better conflict

resolutions. It also provides sharing of the information as not all of the project team members are always available to visit the site in person."

- "One use of our quadcopter allowed us to survey a dock that had been extensively damaged by a tornado. Aerial imagery gave us a better scope of damage than had been first assessed, as well as being able to see outlines of dock debris in the water from a high altitude that was not possible on the surface."
- "Deterioration inspections in hard-to-reach places has proven invaluable for planning repairs."
- "As a consultant rather than a contractor, it is good to have visual understanding of the spatial requirements for construction."
- "General contractors and owners found items in the footage that proved helpful"

• *Comments on usage*

- "Highly efficient"
- "Interior fly-thru found to be useful and unique"
- "The use of waypoints and pre-programmed routes has lots of use. One can follow the same route month by month, with the potential to replace aerial and time lapse photography."

• *Comments on safety*

- "Waypoints, pre-programmed flight makes the experience safer than manual control"
- "Safety on compromised roofs. Faster roof inspections."
- "Safety. Staff not required to access challenging areas."

• *Additional comments on drone use experience*

- "Jobsite personnel get excited when drones are on the job. It boosts morale."
- "Caught issues that would normally not be noticed"
- "Received well by other members of the team"
- [Facilitates] "interaction with the public"
- "Use to produce footage to support community relations and community engagement meetings, particularly for projects with environmentally sensitive elements"
- "Good marketing tool"
- "Fun"

Best Practices

We were heartened to receive several dozen best practice tips from users. While a few are simply common sense, they do represent practices that can improve safe operations, administrative efficiency and data quality. For presentation purposes for this report, we categorized the best practices into four groups:

1. Experience and Training
2. Preparation
3. Operation
4. Precautions

• *Experience and Training*

- Have properly trained operators and equipment
- Get experience prior to flying in public
- Practice, practice, practice
- Set up a training program
- Gain sufficient experience flying drone in open areas and become familiar with all aspects of the drone and controls before taking to a jobsite
- Get training from experienced providers

• *Preparation*

- Use preset flight plans and controls for consistency
- Always conduct a pre-flight checklist to include battery levels on all accessories, cameras and drone
- Plan and follow flight path
- Create a spares kit, including batteries
- Make sure site owner and engineer (owner's rep) know and approve of its use. Get permission in writing if possible.
- Technical explanation to pilots. [Explanation of project and items to be photographed.]
- Have construction specialist present
- Advanced flight pattern planning helps with time management
- Check for proper operation of drone and all accessories before flight
- Perform a low altitude pre-flight (around 5 feet above ground surface) to insure all functions are fully operable.
- Follow the FAA rules - knowbeforeyoufly.org [Note: download the B4UFLY app to your smartphone.]

- Survey area prior to flights and search for nearby airports to insure safe operations [The B4UFLY app, mentioned above, will show the location you plan to fly at relative to nearby airports.]
- Get consent from all parties (for example, all subcontractors for the project)

• *Operation*

- Always use two people. One for flying the drone, the other for the camera.
- Operate within the stated regulations
- Safety first
- Use recommended safety procedures and safety equipment
- Be familiar with the drone. Practice before use.
- Do not operate out of line of sight
- Operate within an acceptable recovery range
- Use during non-peak hours - before or after crews leave
- Stay ahead of the drone and always have a bailout plan
- Be sure camera captures every exterior surface
- Go slow
- Be aware of surroundings

• *Precautions*

- Minimize the public contact as much as possible
- Be courteous and limit your photography to your jobsite
- Ensure proper risk/insurance coverage
- Protect workers
- Obtain an FAA exemption
- Stay away from building interiors
- Always coordinate with all trades and any surrounding areas or facilities
- Put LED lights on drone for spotting, awareness and safety precautions
- Restrict use to "hobby" rules and use hobbyist- or prosumer-grade drones
- Avoid indoor flight with people present and understand realities with battery life
- Expect a crash sooner or later
- Waterproof your drone.
- Ensure software compatibility for sophisticated data processing.

The FAA Regulations

As of the date of this report, the current FAA regulations prohibit the use of drones for commercial applications. Individuals may apply for a “333” exemption. By law, any aircraft operation in the national airspace requires a certificate and registered aircraft, a licensed pilot, and operational approval. Section 333 of the FAA Modernization and Reform Act of 2012 (FMRA) grants the Secretary of Transportation the authority to determine whether an airworthiness certificate is required for a UAS to operate safely in the National Airspace System (NAS).

Some of the respondents to the survey, however, are loosely interpreting the FAA regulations. Some are saying if they fly a drone on private property and are using it only to take pictures for personal use and remain under the 400 foot ceiling, that this is not commercial use and falls into the “hobbyist” category. But there have been rulings that the FAA considers construction site documentation a “commercial use.” A number of the respondents have expressed concern about the FAA requirements and have ceased or limited the operations of drones on construction sites until such time the FAA issues new regulations. Several respondents reported they had a pilot’s license and a handful of others hired a consultant service that employed licensed pilots.

In early 2015, the FAA issued “proposed rules” for public comment. Under the proposed rules, the person actually flying a small UAS would be an “operator.” An operator would have to be at least 17 years old, pass an aeronautical knowledge test and obtain a FAA UAS operator certificate. To maintain certification, the operator would have to pass the FAA knowledge test every 24 months. A small UAS operator would not need any further private pilot certifications (i.e., a private pilot license or medical rating). The new regulations are expected to be released in late spring of 2016 according to *ConstructionPro Network’s* communication with the FAA.

CONCLUSION

Drones are clearly providing beneficial use on construction projects, particularly for surveying, mapping, inspection and aerial photography. In the U.S., at the time of this report, the FAA rules on commercial use are clearly holding back more widespread use. While some contractors are complying by obtaining an FAA exemption or using service providers, others are flying drones at their own risk. For those on projects located on remote sites or otherwise not readily accessible or visible to the public, drone use is considered less risky. Assuming the proposed FAA rules will loosen up the restrictions, construction professionals who anticipate wanting to use drones are encouraged to obtain one and practice in open areas in compliance with FAA regulations. In the interim, consider hiring a service provider.

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